Faculty of Science

Discovering for tomorrow

Nelson Mandela Metropolitan University

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Environmental analysis of pneumatic tyres:
Chemical Analyses Methods towards Environmental rating of Tyres

African Marine Waste Conference: Circular Economy
The Feather Market Centre, Port Elizabeth
9-13 July, 2017

Sibeko Motshabi

Introduction

- Waste management

Waste management hierarchy
(within the context of SA's NWMS and NEMWA [1])

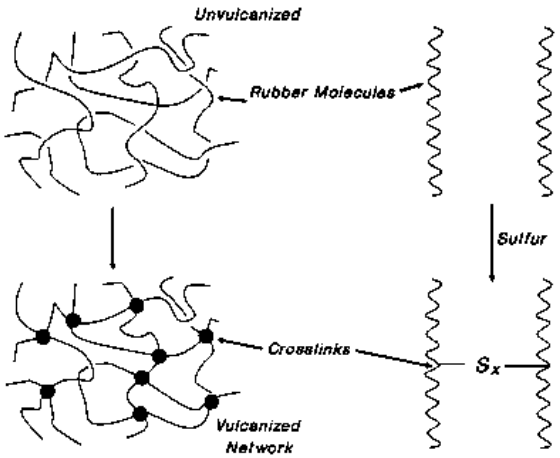
"Polluter pays principle"

- The strategy provides an incentive for manufactures to reduce waste generated and environmental impact of their products by:
  - Changing the inputs or materials used in their products
  - Or re-thinking product design

Introduction con…

- **Tyres**

Tyre components [2]

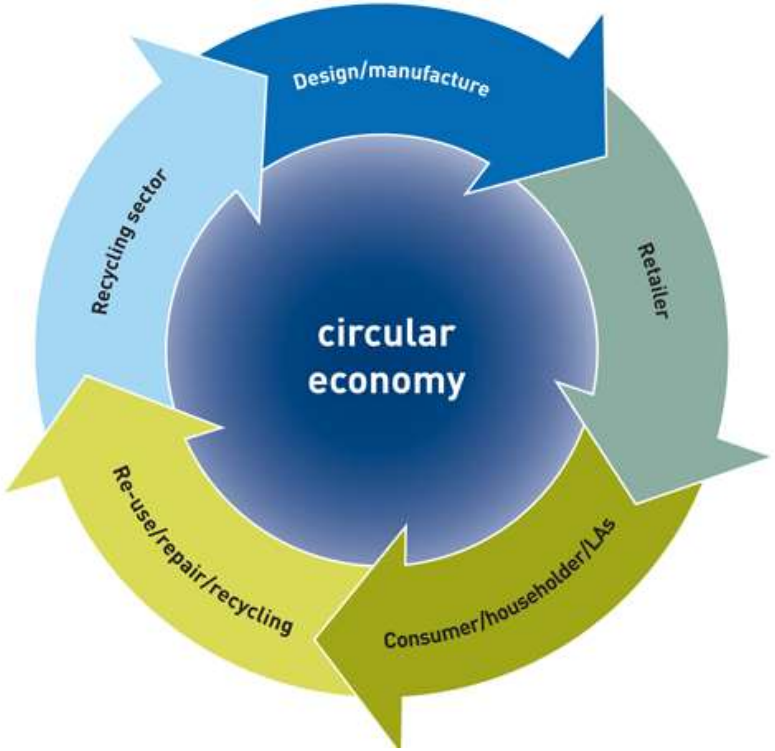


Typical tyre formulation

Constituents (%)	Ingredients
Rubber (40-60)	NR, SBR, BR
Reinforcing filler (25-35)	Carbon black, silica
Processing oils (15-20)	Aromatic, paraffinic
Vulcanization agents (1-2)	Sulphur
Activators (2-5)	ZnO
Accelerators (0.5-2)	MBT
Antidegradants (1-2)	TMQ

Circular economy

Linear economy = Take → Make → Dispose



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End-of-life management of waste tyres

Applications of crumb rubber

- Sport surfaces
- Automotive industry
- Construction
- Asphalt applications
- Adhesives/Sealants
- Rubber and plastic products

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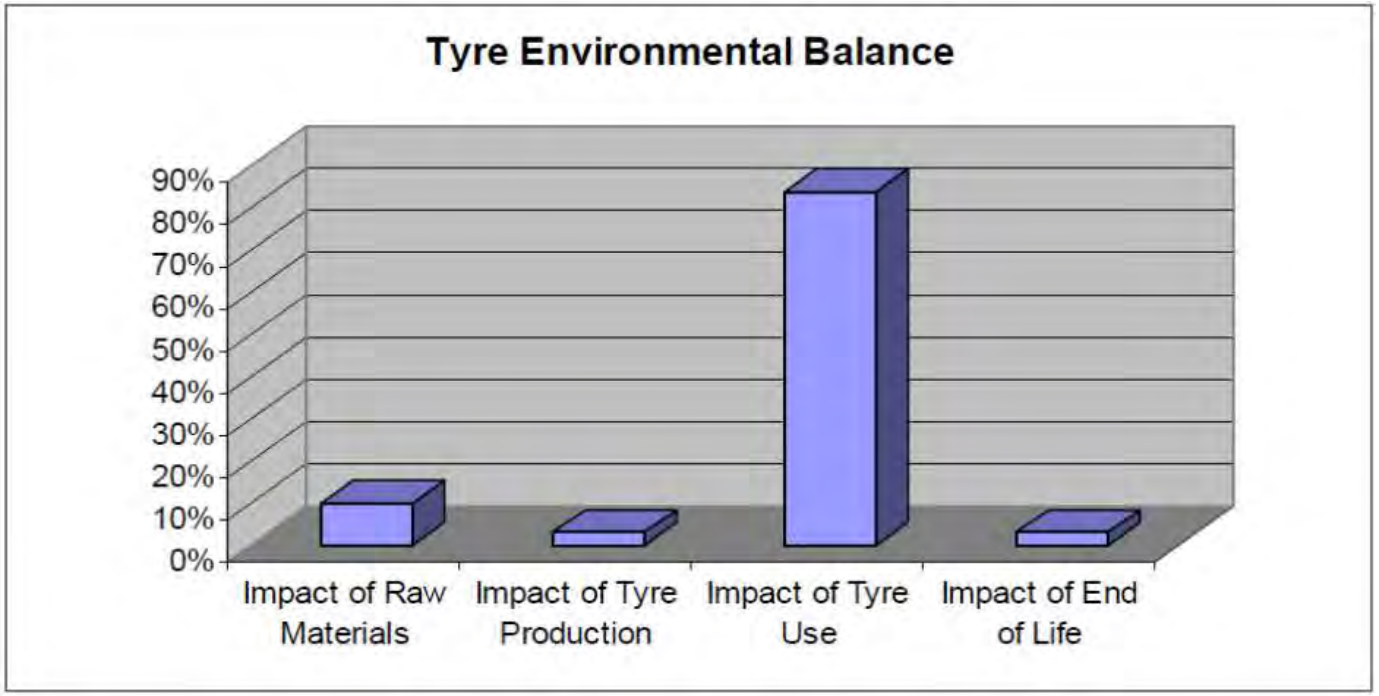
Environmental impact of tyre



Environmental impact of tyre
(European tyre & rubber manufactures association (2001))

- The NEMA introduced the life-cycle analysis (LCA) approach to waste management
- LCA involves looking at all stages of a product's life and find where improvements can be made to reduce environmental impacts and improve the use or reuse of resources.

Challenges and waste tyre management in SA

Toxic gas emissions

REDISA
RECYCLING AND ECONOMIC DEVELOPMENT INITIATIVE OF SOUTH AFRICA

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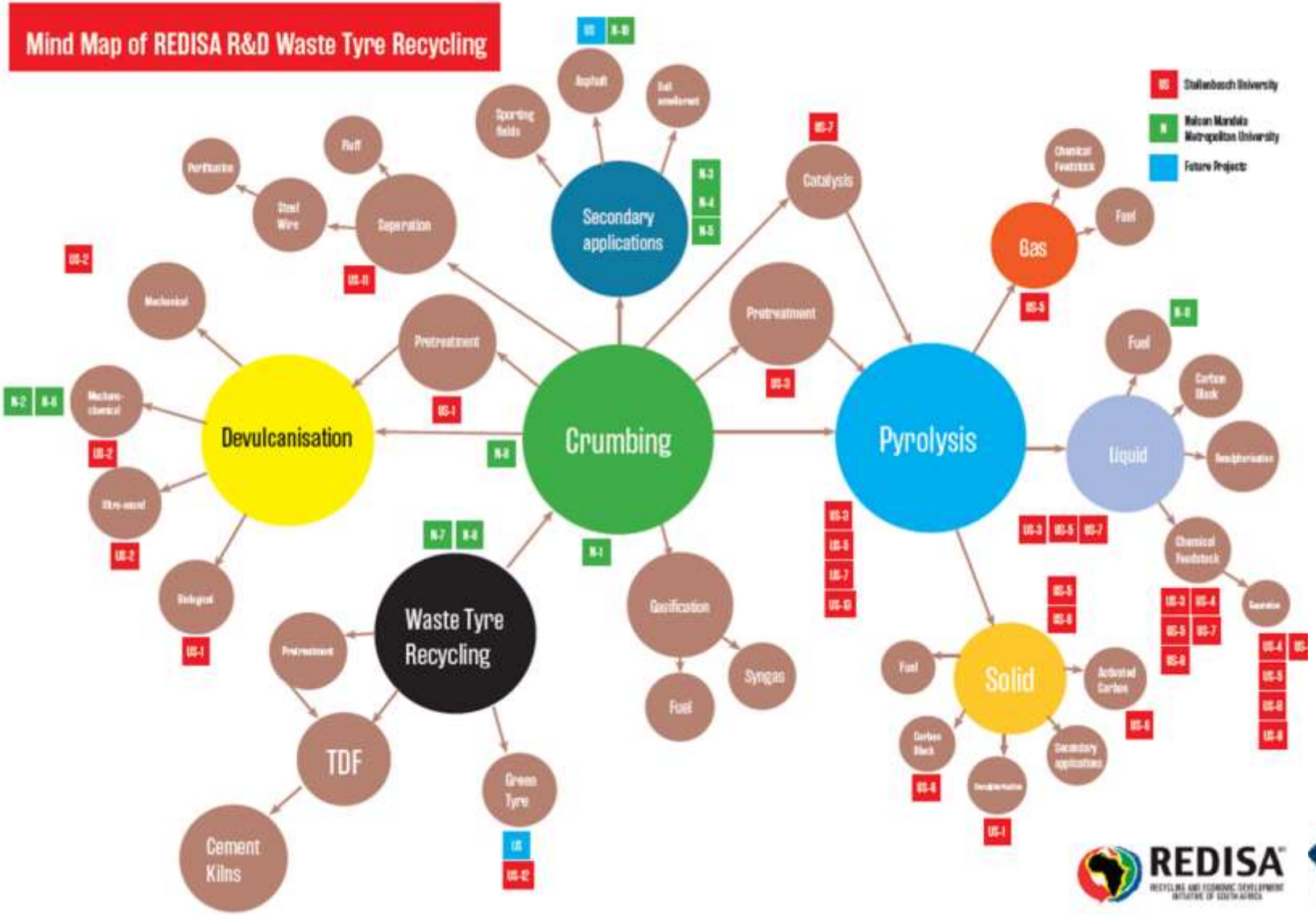
REDISA: Circular economy

"Turning waste into worth"



Current projects at NMMU

Waste tyres

Polymers

Bitumen

Tarred road

Crumb rubber

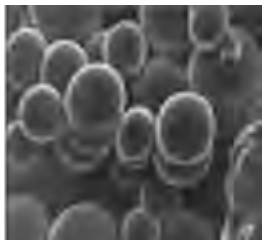
Sidewalk bricks

Diesel

Waste tyre oil

Pavement sealant

Wild garlic

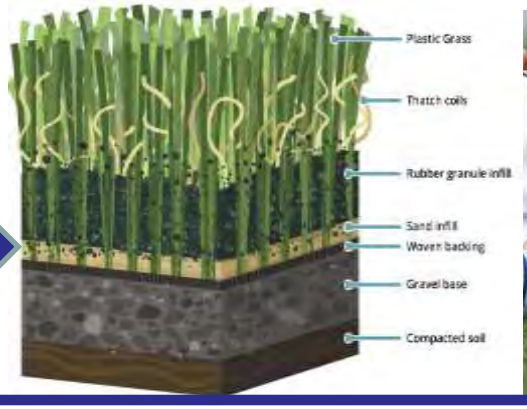


Latex products

Reclaim rubber

Applications of waste tyres

Artificial turf



Children's playground

Artificial reefs

Florida
1972, waste tyres

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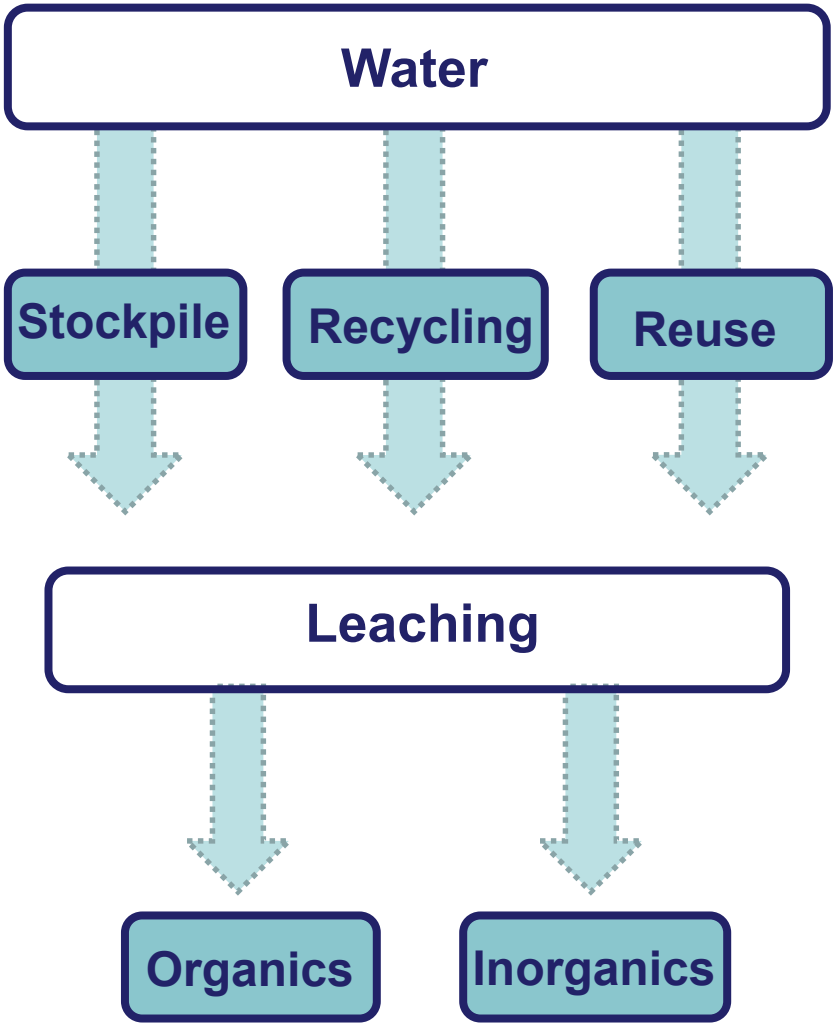
Problem identification

Scrap tyres



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The national pricing strategy

Published 11 August 2016

Aim of the Pricing Strategy

- ❖ Mainstream the Polluter Pays Principle as intended in the NWMS
- ❖ Reduce the generation of waste
- ❖ Increase the diversion of waste away from landfill towards recovery, recycling and reuse

Strategy highlights that:

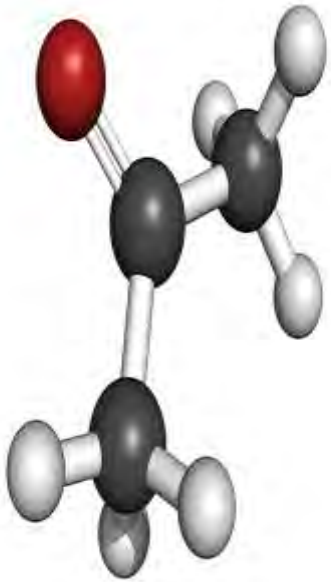
- ❑ Size of the levy needs to be related directly to the environmental damage
- ❑ Factors determining the charges
- ➢ Toxicity or degree of hazard of material components
- ➢ Ease with which the product can be dismantled and the components recycled…

Proposed key points for a Rating System

- Hazardous materials
- Ease of recycling or raw material recovery
- Use of recycled input materials
- Carbon dioxide emission
- Resources consumption in manufacture
- Product lifetime

Hazardous materials in tyres

Heavy metals



VOCs

Process oil

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Historical and regulatory timeline

1995: Tyre industry association established a group to study solutions for replacement of aromatic oils (maintaining the performance and safety of tyre)

2003: Precautionary approach of European tyre industry to phase-out aromatic extender oil

2005: EC adopted a Directive (2005/69/EC) restricting the marked and use of aromatic oils and of tyres produced after 1 January 2010

2007: REACH Regulation (EC) 1907/2006: Entry 50 Annex XVII contains a list of PAHs that are restricted in oils used for tyre production

2010: Entry into force of REACH Annex XVII Entry 50 restriction on the use of aromatic oils

Regulatory compliance

Benzo[a]pyrene (BaP)

Benzo[e]pyrene (BeP)

Benzo[a]anthracene (BaA)

Chrysen (CHR)

Benzo[b]fluoranthene (BbFA)

Benzo[j]fluoranthene (BjFA)

Benzo[k]fluoranthene (BkFA)

Dibenzo[a,h]anthracene (DBahA)

- **Extender oil should not be on the marked if they contain:**
  - >1 mg/kg (0.0001% by weight) BaP
  - >10 mg/kg (0.001 % by weight) sum PAHs

“If we can measure it, we can manage it”

First phase

Heavy metals

- Identification and quantification of heavy metals found in tyres
- Conditions (pH) preferred for secondary applications
- Influence of rubber crumb size on leaching
- Pre-treatment (washing) of rubber crumbs prior to reuse applications

VOCs

- Identification and quantification of VOCs in tyres

Process oil

- Identification and quantification of process oil used in tyres
- Evaluate producer compliance with EU regulations

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Standard techniques

Oil analyses

Nuclear Magnetic Resonance Spectroscopy (NMR)

Gas Chromatography Mass Spectroscopy (GC-MS)

VOCs analysis

Headspace

Heavy Metal Detection

Microwave digester

Atomic Adsorption Spectroscopy (Qualitative and Quantitative)

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Closing remarks

- In an ideal world, products should be made without using toxic chemicals
- Driving towards a circular economy, products must be recycled into the same or similar products, or be able to be reduced to raw materials that could be re-introduced into the manufacturing cycle

Acknowledgements

- REDISA

- Center for Rubber Science and Technology (CRST)

- Nelson Mandela Metropolitan University (NMMU)

- African Marine Waste Network

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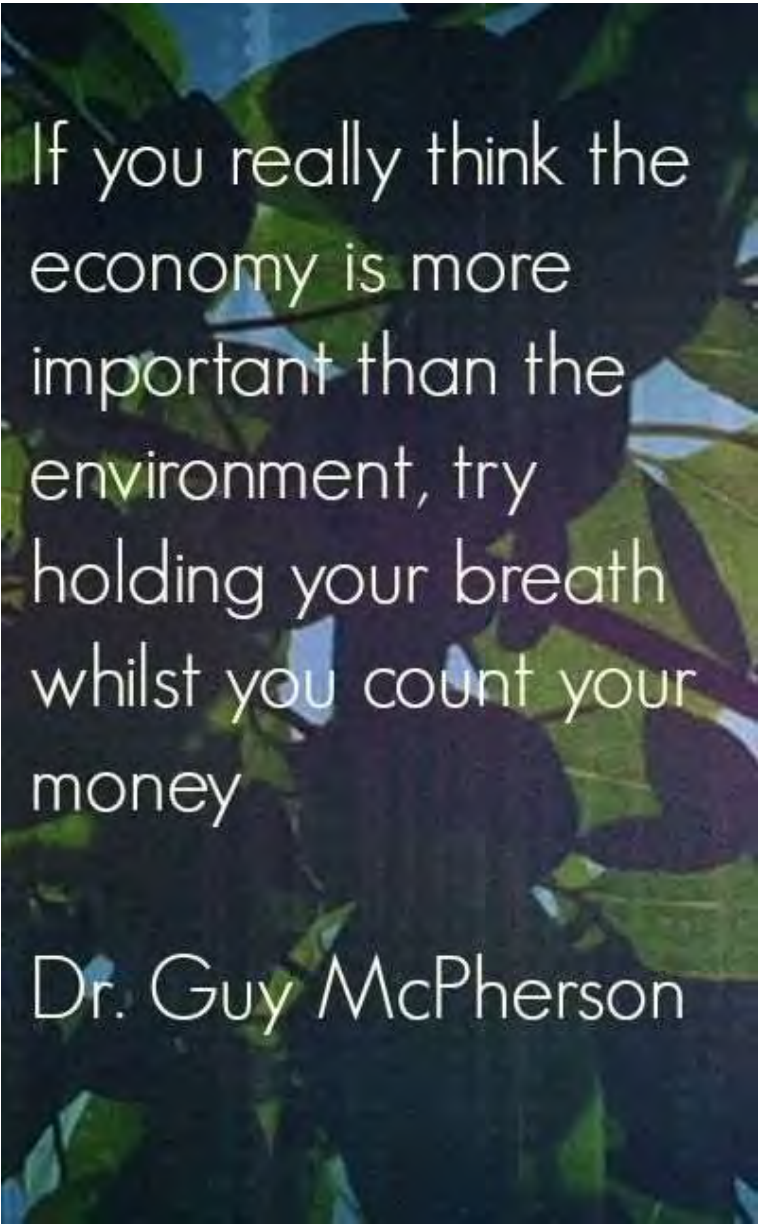
Thank you for listening



Be the change
If we can measure it, we can manage it
One persons trash can be another persons

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